Fighting wildfires with computer models

August 27, 2019

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Many ecosystems in the United States developed in the presence of fire. Over millennia, flames have regularly swept across landscapes, often at smaller scales and with lower intensity than today's forest fires. They cleared out excess fuels such as smaller trees, fallen wood and leaf litter in a self-regulating process that fragmented the landscape, limiting the size of fires and keeping the forest healthy. In many western forests, this resulted in widely spaced trees, thinner understory and less combustible litter on the ground than we commonly see now.

But human intervention has interrupted that natural process, allowing excess fuels to accumulate—and those fuels have got to go one way or another. For many years in the southeastern United States, land managers have engineered controllable, prescribed burns to remove a majority of the accumulated fuels on the ground; a significant amount in the forest midstory and some in the canopy.

Sometimes, however, prescribed burns go badly wrong.

It happened in Bandelier National Monument in New Mexico in 2000, when a prescribed burn blew up into a megafire that torched more than 47,000 acres in the Jemez Mountains and more than 230 homes in the nearby town of Los Alamos, displacing more than 400 people.

More recently, huge fires in California and Tennessee have focused long-overdue attention on how best to use prescribed fire to prevent such conflagrations. And while intentionally setting a controlled fire clears out excess fuels and rebalances ecosystems, planning and successfully carrying out this strategy can be a tricky business. That's especially true in the complex mountain-and-canyon terrain of the West, where more and more people live near wild lands. And yet, if fuel loads are not kept in check, we can expect more catastrophic fires—huge, immensely destructive and deadly.

Experience with previous free-burning wildfires can help fire managers decide how to proceed, but since every fire is different, this is an imperfect solution This is where physics-based fire modeling can make a big difference. Modeling allows fire managers to simulate prescribed fires in advance, so that when crews start laying down flames from drip torches across the landscape, they can confidently set the right fire at the right time. They want just enough fire to sustain itself but not so much that it gets out of control. The FIRETEC modeling tool, developed at Los Alamos National Laboratory, leverages fluid-dynamics research originally developed for national security science and uses physics to represent the critical interactions among the multiple ignitions of a prescribed burn in very complex terrain.

This story first appeared in [Scientific American.]

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